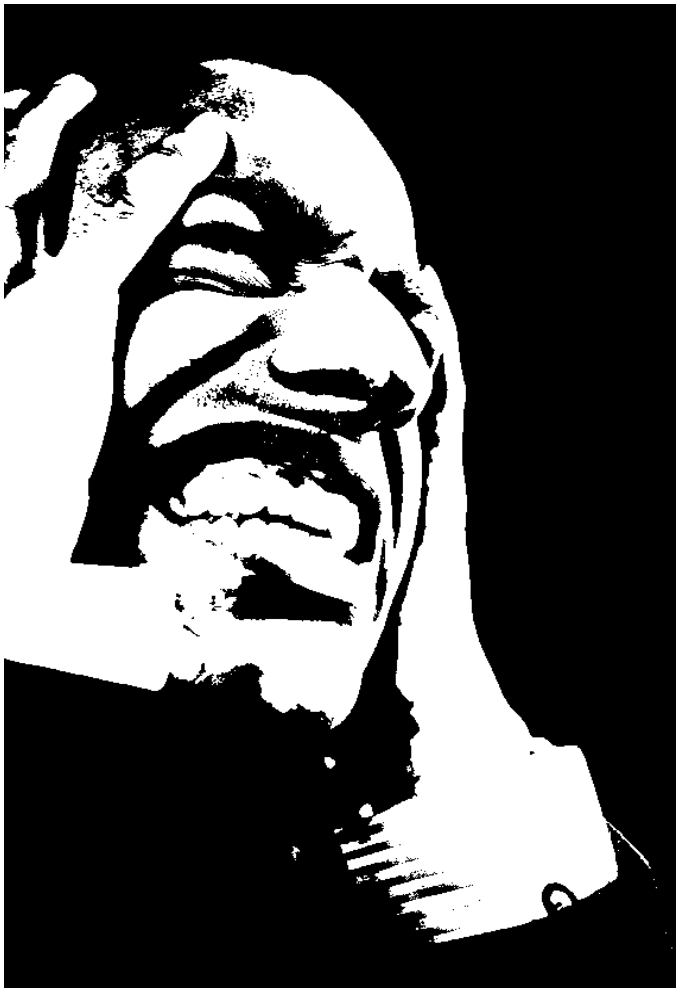
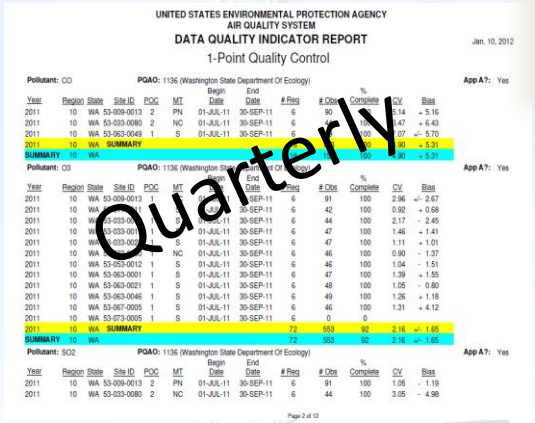
Appendix A: Calculations for Data Quality Assessment

- **QC check statistics**
- **Precision calcs**
- **Bias calcs**
- **PM stats**
- **Reporting: quarterly and annual**



AMP 255 Report


UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
AIR QUALITY SYSTEM
DATA QUALITY INDICATOR REPORT
1-Point Quality Control
Jan. 10, 2012

Pollutant: CO PQAO: 1136 (Washington State Department Of Ecology) App A?: Yes

Year	Region	State	Site ID	POC	MT	Begin Date	End Date	# Req	# Obs	% Complete	CV	Bias
2011	10	WA	53-009-0013	2	PN	01-JUL-11	30-SEP-11	6	90	100	5.14	+ 5.16
2011	10	WA	53-033-0080	2	NC	01-JUL-11	30-SEP-11	6	44	100	3.47	+ 6.43
2011	10	WA	53-063-0049	1	S	01-JUL-11	30-SEP-11	6	19	100	7.07	+/- 5.70
2011	10	WA	SUMMARY					18	153	100	4.90	+ 5.31
SUMMARY	10	WA						18	153	100	4.90	+ 5.31

Pollutant: O3 PQAO: 1136 (Washington State Department Of Ecology) App A?: Yes

Year	Region	State	Site ID	POC	MT	Begin Date	End Date	# Req	# Obs	% Complete	CV	Bias
2011	10	WA	53-009-0013	1		01-JUL-11	30-SEP-11	6	91	100	2.96	+/- 2.67
2011	10	WA	53-011-0011	1	S	01-JUL-11	30-SEP-11	6	42	100	0.92	+ 0.68
2011	10	WA	53-033-0010	1	S	01-JUL-11	30-SEP-11	6	44	100	2.17	- 2.45
2011	10	WA	53-033-0017	1	S	01-JUL-11	30-SEP-11	6	47	100	1.46	+ 1.41
2011	10	WA	53-033-0024	1	S	01-JUL-11	30-SEP-11	6	47	100	1.11	+ 1.01
2011	10	WA	53-033-0080	1	NC	01-JUL-11	30-SEP-11	6	46	100	0.90	- 1.37
2011	10	WA	53-053-0012	1	S	01-JUL-11	30-SEP-11	6	46	100	1.04	- 1.51
2011	10	WA	53-063-0001	1	S	01-JUL-11	30-SEP-11	6	47	100	1.39	+ 1.55
2011	10	WA	53-063-0021	1	S	01-JUL-11	30-SEP-11	6	48	100	1.05	- 0.80
2011	10	WA	53-063-0046	1	S	01-JUL-11	30-SEP-11	6	49	100	1.26	+ 1.18
2011	10	WA	53-067-0005	1	S	01-JUL-11	30-SEP-11	6	46	100	1.31	+ 4.12
2011	10	WA	53-073-0005	1	S	01-JUL-11	30-SEP-11	6	0	0		
2011	10	WA	SUMMARY					72	553	92	2.16	+/- 1.65
SUMMARY	10	WA						72	553	92	2.16	+/- 1.65

Pollutant: SO2 PQAO: 1136 (Washington State Department Of Ecology) App A?: Yes

Year	Region	State	Site ID	POC	MT	Begin Date	End Date	# Req	# Obs	% Complete	CV	Bias
2011	10	WA	53-009-0013	2	PN	01-JUL-11	30-SEP-11	6	91	100	1.05	- 1.19
2011	10	WA	53-033-0080	2	NC	01-JUL-11	30-SEP-11	6	44	100	3.05	- 4.98

Page 2 of 12

Quarterly

Yearly

3 Years

O_3 Assessments

Site ID: {Enter Site ID}	Pollutant type: O_3		CV_{ub} (%)	Bias (%)
Meas Val (X)	Audit Val (Y)	d (Eqn 1) 25th Percentile	d^2	$	d	$	$	d	^2$
87	81	6.098	37.180	6.098	37.180	5	39.205	261.435	261.435
87	81	7.407	54.870	7.407	54.870				

DASC

Anytime

"AB" (Eqn 4) 6.534

"AS" (Eqn 5) 1.026

Bias (%) (Eqn 3) 7.38

Both Signs Positive TRUE

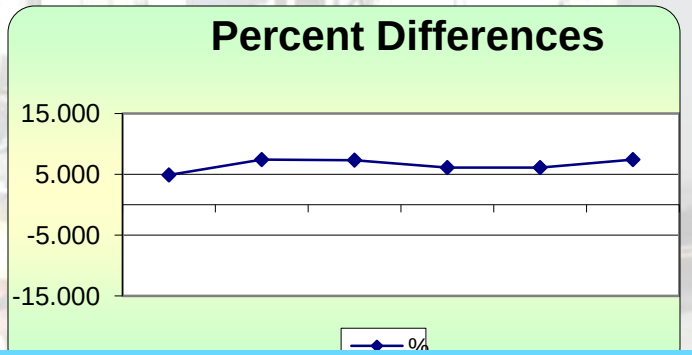
Signed Bias (%) +7.38

Both Signs Negative FALSE

CV (%) (Eqn 2) 1.81

Upper Probability Limit 8.54

Lower Probability Limit 4.52



Part 1-ozone precision

What do you need to know about how the routine QC checks (~90 per qtr if done nightly) are used? How should YOU use them?

Sections 4 and 5—Use the DASC Tool to Understand Your QC Checks and Audit Results (like EPA does)

- Calculations of measurement uncertainty are carried out by EPA, *and* PQAOs should report the data for all appropriate measurement quality checks
- YOU do these calculations and charts easily, and save yourself time, money, and embarrassment

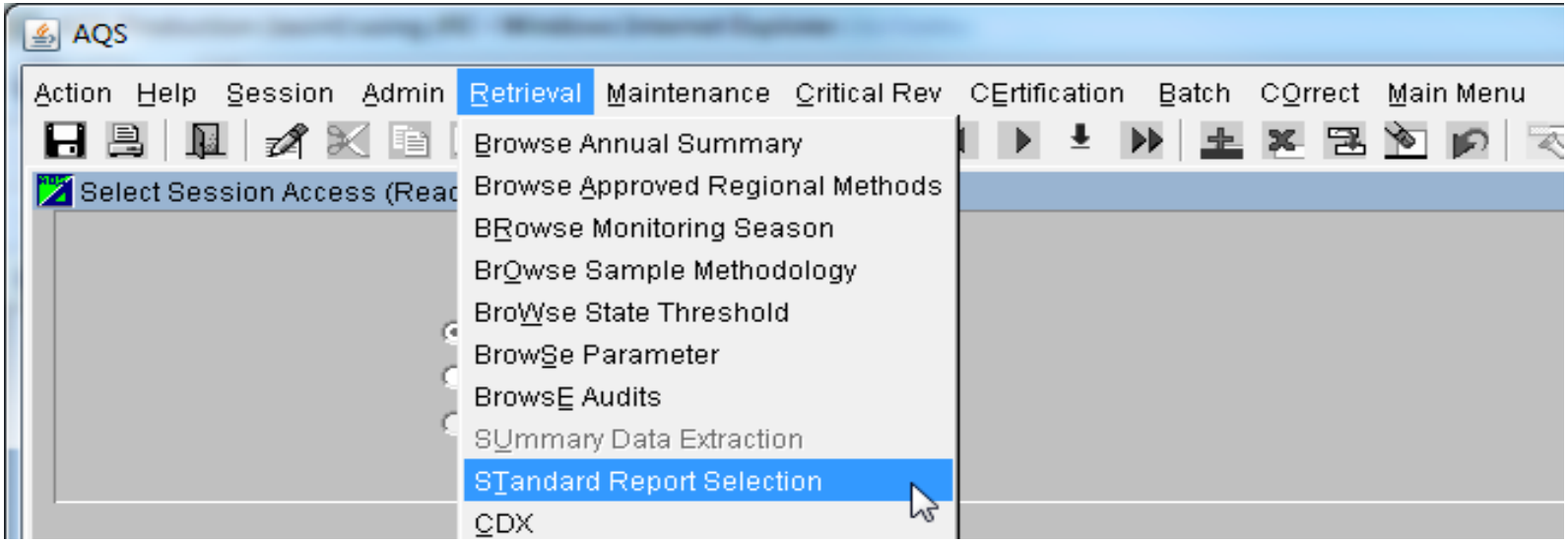
We will review each in both the DASC tool and the AMP255 report

First, what is the DASC tool?

- DASC tool was produced specifically for us to calculate the data assessment statistics in CFR in AMTIC Quality Indicator Assessment Reports (AMP255)
- **http://www.epa.gov/ttn/amtic/qareport.html**
- Easy way to explain and calculate data assessment statistics in CFR
- Excel spreadsheet
- Matches AMP255 (by site)
- Each equation is numbered and matches the numbers in CFR

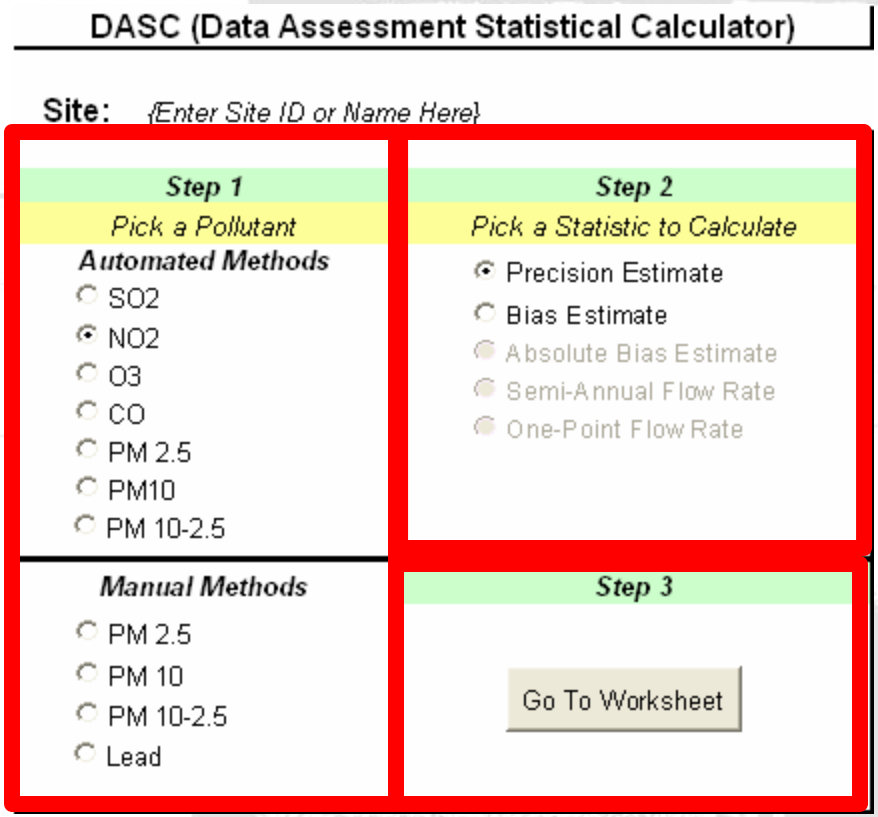
What is the AMP255-Data Quality Indicators Report?

- AQS Standard Report to Compute the Statistics Outlined on 40 CFR Part 58 Appendix A
- Part of the Annual Certification Process to Verify Submission of QA and routine Data to AQS



- CORRESPONDS to what you calculate in the DASC tool
- But 1st let's review the helpful DASC file:

Data Assessment Statistical Calculator (DASC)



Contains 12 different worksheets including menu

Understanding the Terminology

- "Meas" is the concentration indicated by the monitoring organization's instrument
- "Audit" is the audit standard used in the QC check being measured, or "known" value
- (meas-audit)/audit= $\mathbf{d_i}$

Calibrations Results for Fourth Quarter 2011

Date	Monitor	Units	ZRef	ZMeas	SRef	SMeas	Zero	Factor	SDiff%	ZStd	SStd	Status
10/2/2011 2:57 AM	O3	ppm	0.000	0.001	0.081	0.080	0.001	1.019	-1.2	0.000	0.000	Valid
10/4/2011 2:57 AM	O3	ppm	-0.001	0.001	0.081	0.080	0.001	1.016	-1.2	0.000	0.000	Valid
10/6/2011 2:57 AM	O3	ppm	-0.001	0.000	0.081	0.081	0.001	1.005	0.0	0.000	0.000	Valid
10/8/2011 2:57 AM	O3	ppm	-0.001	0.001	0.081	0.081	0.002	1.014	0.0	0.000	0.000	Valid
10/10/2011 2:57 AM	O3	ppm	0.000	0.001	0.081	0.081	0.001	1.008	0.0	0.000	0.000	Valid
10/12/2011 2:57 AM	O3	ppm	0.000	0.001	0.081	0.081	0.001	1.027	0.0	0.000	0.000	Valid
10/14/2011 2:57 AM	O3	ppm	0.000	0.001	0.081	0.081	0.001	1.013	0.0	0.000	0.000	Valid
10/16/2011 2:57 AM	O3	ppm	-0.001	0.001	0.081	0.081	0.002	1.011	0.0	0.000	0.000	Valid
10/18/2011 2:57 AM	O3	ppm	0.000	0.001	0.081	0.081	0.001	1.011	0.0	0.000	0.000	Valid
10/20/2011 2:57 AM	O3	ppm	-0.002	0.000	0.081	0.084	0.002	0.971	3.7	0.000	0.000	Valid
10/22/2011 2:57 AM	O3	ppm	-0.002	0.000	0.081	0.086	0.002	0.947	6.1	0.000	0.000	Valid
10/24/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.087	0.003	0.952	6.0	0.000	0.000	Valid
10/26/2011 2:57 AM	O3	ppm	-0.002	0.000	0.082	0.086	0.002	0.947	4.8	0.000	0.000	Valid
10/28/2011 2:57 AM	O3	ppm	-0.002	0.000	0.082	0.086	0.002	0.950	4.8	0.000	0.000	Valid
10/30/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.086	0.003	0.958	4.8	0.000	0.000	Valid
11/1/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.087	0.003	0.940	7.4	0.000	0.000	Valid
11/3/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.088	0.003	0.941	7.3	0.000	0.000	Invalid
11/5/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.087	0.003	0.942	6.0	0.000	0.000	Valid
11/7/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.087	0.003	0.955	6.0	0.000	0.000	Valid
11/9/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.087	0.003	0.944	7.4	0.000	0.000	Valid
11/11/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.087	0.003	0.946	7.4	0.000	0.000	Invalid
11/13/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.087	0.003	0.939	7.4	0.000	0.000	Invalid
11/15/2011 2:57 AM	O3	ppm	-0.002	0.000	0.082	0.087	0.002	0.948	6.0	0.000	0.000	Valid
11/17/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.087	0.003	0.949	6.0	0.000	0.000	Valid
11/19/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.087	0.003	0.941	7.4	0.000	0.000	Invalid
11/21/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.087	0.003	0.943	7.4	0.000	0.000	Valid
11/23/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.088	0.003	0.944	7.3	0.000	0.000	Valid
11/25/2011 2:57 AM	O3	ppm	-0.003	0.000	0.082	0.087	0.003	0.945	6.0	0.000	0.000	Valid
11/27/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.087	0.003	0.951	6.0	0.000	0.000	Valid
11/29/2011 2:57 AM	O3	ppm	-0.002	0.000	0.082	0.087	0.002	0.944	6.0	0.000	0.000	Valid
12/1/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.086	0.003	0.961	4.8	0.000	0.000	Valid
12/3/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.087	0.003	0.956	6.0	0.000	0.000	Valid
12/5/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.087	0.003	0.948	7.4	0.000	0.000	Valid
12/7/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.086	0.003	0.961	4.8	0.000	0.000	Valid
12/9/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.087	0.003	0.942	7.4	0.000	0.000	Invalid
12/11/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.087	0.003	0.950	6.0	0.000	0.000	Valid
12/12/2011 2:42 PM	O3	ppm	-0.002	0.001	0.082	0.087	0.003	0.952	6.0	0.000	0.000	Valid
12/13/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.086	0.003	0.949	6.1	0.000	0.000	Valid
12/15/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.086	0.003	0.957	6.1	0.000	0.000	Valid
12/17/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.086	0.003	0.953	6.1	0.000	0.000	Valid
12/19/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.086	0.002	0.958	4.8	0.000	0.000	Valid
12/21/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.087	0.003	0.945	7.4	0.000	0.000	Valid
12/23/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.086	0.003	0.954	6.1	0.000	0.000	Valid
12/25/2011 2:57 AM	O3	ppm	-0.002	0.001	0.082	0.087	0.003	0.949	6.0	0.000	0.000	Valid
12/27/2011 2:57 AM	O3	ppm	-0.002	0.001	0.081	0.086	0.003	0.951	6.1	0.000	0.000	Valid
12/29/2011 2:57 AM	O3	ppm	-0.003	0.001	0.082	0.087	0.004	0.954	6.0	0.000	0.000	Valid

GAS QC check precision statistics (CFR App A, 4.1)

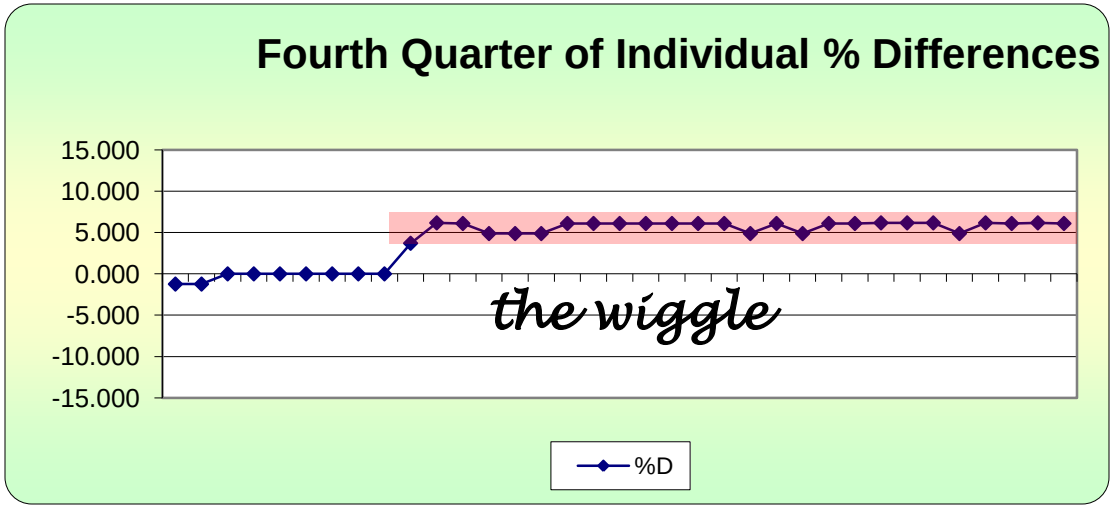
- All statistics start from the difference between your instrument's indicated value and the known (audit) value (meas-known)/known= $\mathbf{d_i}$
- Both precision (wiggle) and bias (jump) are calculated from $\mathbf{d_i}$
- EPA calculates **precision** from these checks both by site and by PQAO
- These QC checks are then aggregated into "**upper bound of the CV**" for site and for PQAO
- The annual PE and NPAP results are used to *verify* the precision CVs

DASC tool will plot these values for you in control charts:

Meas Val (Y)	Audit Val (X)	d (Eqn. 1)
0.08	0.081	-1.235
0.08	0.081	-1.235
0.081	0.081	0.000
0.081	0.081	0.000
0.081	0.081	0.000
0.081	0.081	0.000
0.081	0.081	0.000
0.081	0.081	0.000
0.081	0.081	0.000
0.084	0.081	3.704
0.086	0.081	6.173
0.087	0.082	6.098
0.086	0.082	4.878
0.086	0.082	4.878
0.086	0.082	4.878
0.087	0.082	6.098
0.087	0.082	6.098

CV (%) (Eqn 2)

3.27



GAS QC check precision (cont.)

- You can be **90% sure that your true precision is less than** this "upper bound of the CV"
- Guidance: *each* **d_i** should be <7% for O_3, 10% for other gasses
- Then calculate your ***overall* CV** (based on many **d_i**) by using DASC
- From DASC we see:

CV (%) (Eq'n 2)
3.27

- Corresponds to **CV** in AMP255 (EPA calculates both for each site and for your whole PQAO network)

DATA QUALITY INDICATOR REPORT

1-Point Quality Control

O3 **PQAO:** 1136 (Washington State Department Of Ecology)

Region	State	Site ID	POC	MT	Begin Date	End Date	# Req	# Obs	% Complete	CV	Bias
10	WA	53-053-0012	1	S	01-OCT-11	31-DEC-11	6	35	100	3.27	+ 5.0

Summary of precision:

- Calculated from routine QC checks d_i
- each check should be < 7% for O3, 10% other gasses
- Overall upper bound of CV calculated from d_i
- you can be **90% sure that your true precision is less than** this “upper bound of the CV” (eq’n 2)

Thanks Shelly Eberly!

Part 2-ozone bias

What do you need to know about how the routine QC checks (~90 per qtr if done nightly) are used? How should YOU use them, for BIAS?

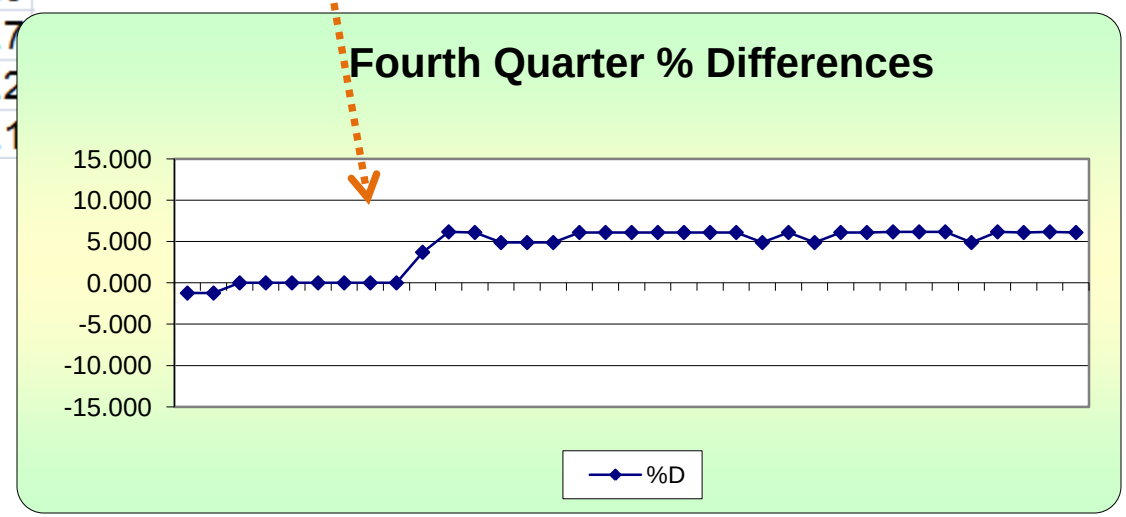
Bias statistics (CFR App A, 4.1.3):

- Remember that bias as well as precision starts from the difference between your instrument's indicated value and the known (audit) value (meas-known)/known= d_i
- bias (jump) is calculated from d_i
- Bias just *based on* the AVERAGE of the d_i with the sign taken into account (if your analyzer is always higher than the known, you have a high (+) bias

Bias is in DASC tool in the same sheet as precision (O3 P&B) and uses the same input:

Meas Val (Y)	Audit Val (X)	d_i (Eqn. 1)
0.08	0.081	-1.2
0.08	0.081	-1.2
0.081	0.081	0.0
0.081	0.081	0.0
0.081	0.081	0.0
0.081	0.081	0.0
0.081	0.081	0.0
0.081	0.081	0.0
0.081	0.081	0.0
0.084	0.081	3.7
0.086	0.081	6.2
0.087	0.082	6.1

Signed Bias (%)
+5.05



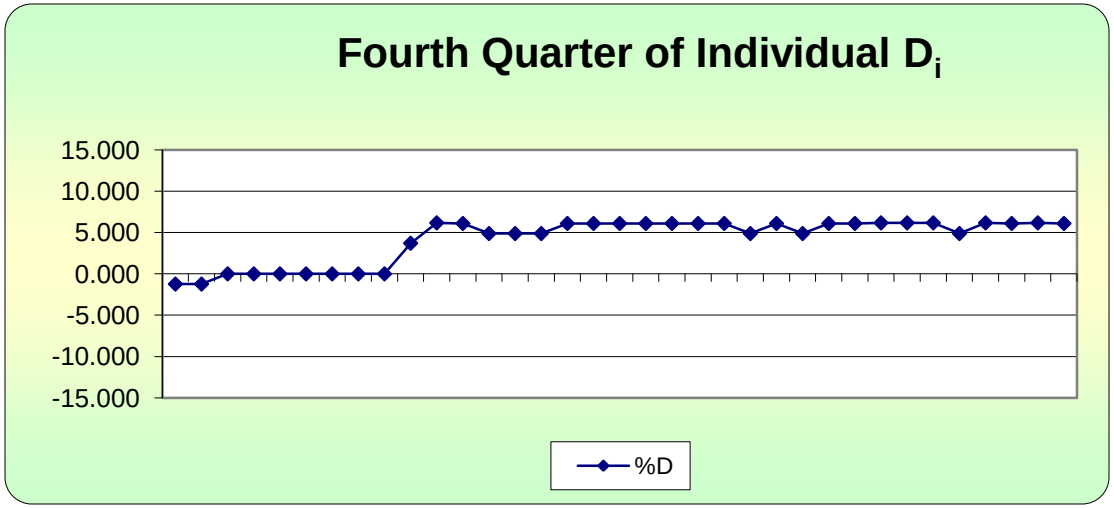
GAS QC check bias statistics (CFR App A, 4.1)

- All statistics start from the difference between your instrument's indicated value and the known (audit) value (meas-known)/known= $\mathbf{d_i}$
- **bias (jump)** is also calculated from $\mathbf{d_i}$
- Known bias uses the average of all the $\mathbf{d_i}$ values, and adds a factor based on t-statistic to get an upper bound for the bias
- Then, DASC looks at whether the bias is generally + or generally negative, based on the 25% and 75% percentiles—if both are + then you have a high bias

Bias:

- Bias is high
- Both percentiles are + so bias is +

25th Percentile
1.9
75th Percentile
6.1



Bias (%) (Eqn 3)
5.05
Signed Bias (%)
+5.05

GAS QC check bias(cont.):

- you can be ~ **95% sure that the absolute value of your bias is less than** this upper bound
- Guidance: each d_i should be <7% for O_3, 10% for other gasses
- The ***upper limit of your overall* bias** (based on many d_i) you calculate using DASC
- From DASC we see:

Signed Bias (%)
+5.05

- Corresponds to **Bias** in AMP255 (EPA calculates both for each site and for your whole PQAO network)

DATA QUALITY INDICATOR REPORT

1-Point Quality Control

PQAO: 1136 (Washington State Department Of Ecology)

egion	State	Site ID	POC	MT	Begin Date	End Date	# Req	# Obs	% Complete	CV	Bias
10	WA	53-053-0012	1	S	01-OCT-11	31-DEC-11	6	35	100	3.27	+ 5.05

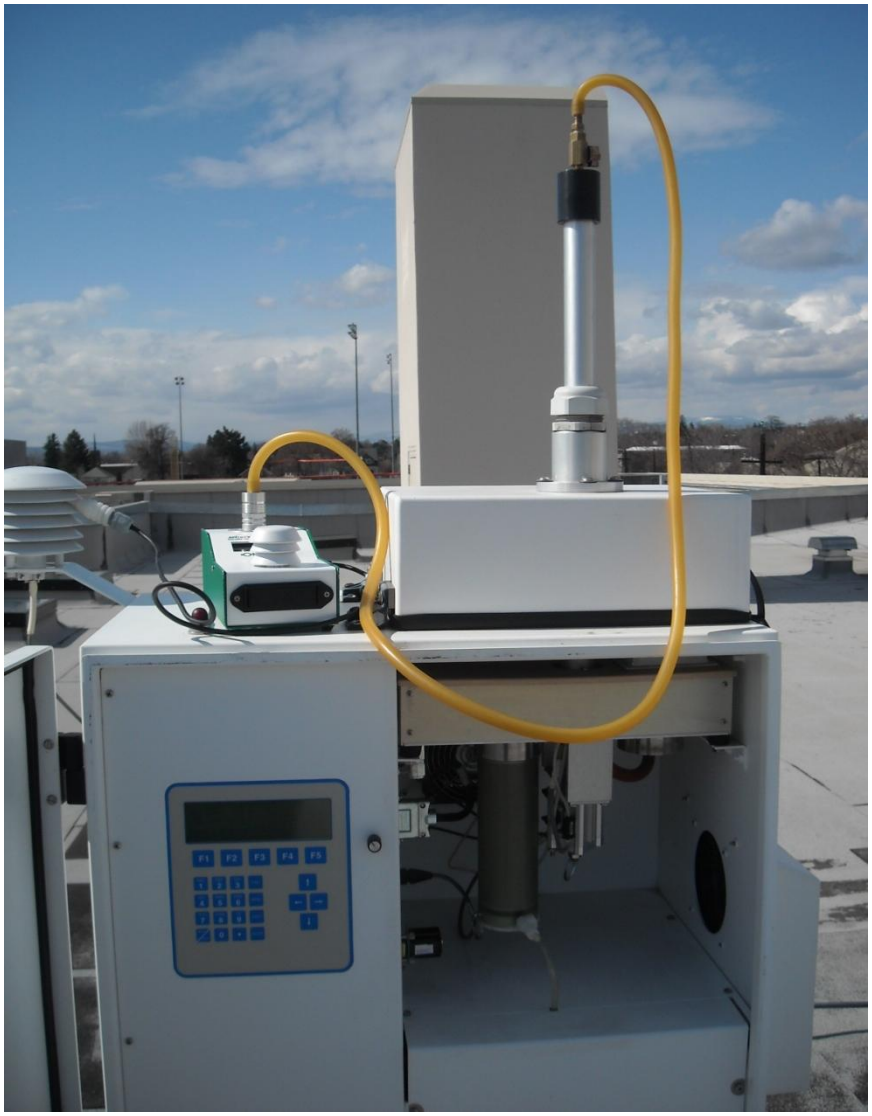
Summary of gas bias:

- Calculated from routine QC checks d_i
- each check should be < 7% for O_3, 10% other gasses, then the:
- Overall upper limit of bias calculated from d_i
- Then look at the sign (and the chart) for whether your analyzer is biased high (+) or low (-)

Part 3-PM flow rate (FR) check stats

What do you need to know about how you can use your monthly FR check results? What about the 6-mo FR checks? How can the DASC help you make sense of them?

Routine monthly FR checks:



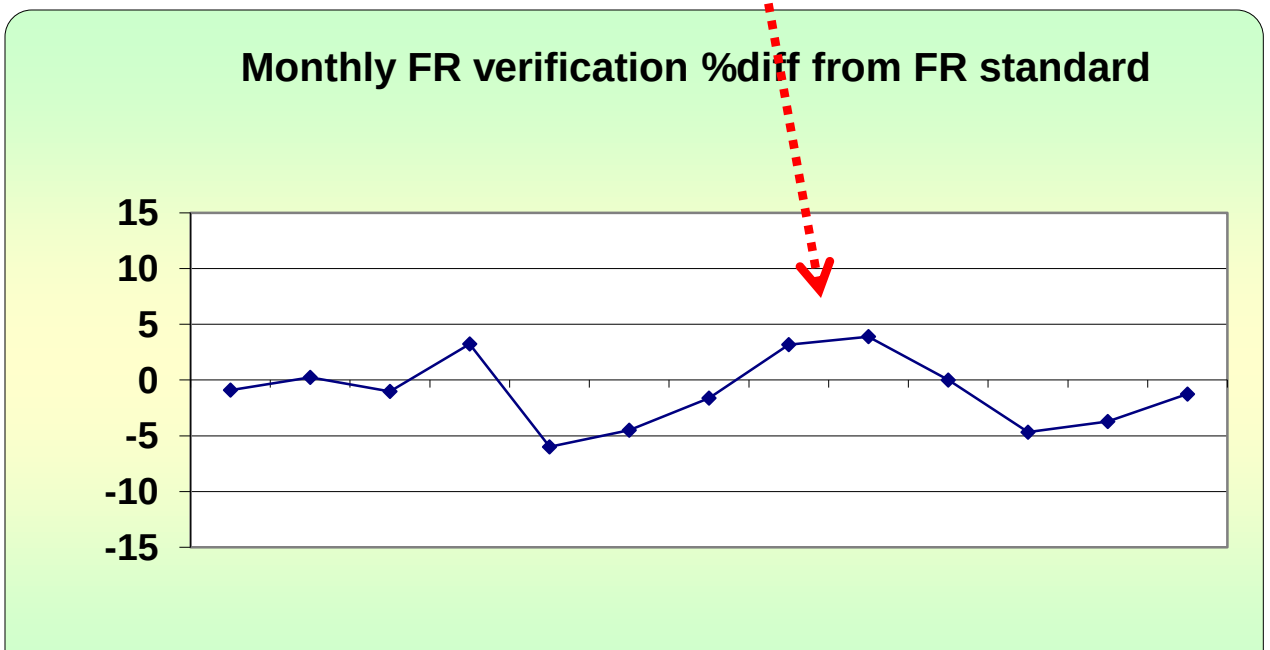
- Used by YOU to track your FR
- Used by EPA to estimate your bias and compare with your 6-mo FR audit results
- Uses same stats as gaseous, starting with d_i
- (meas-known)/known= d_i

Monthly FR verifications in DASC-what you can do:

Meas Val (Y)	Audit Val (X)	d (Eqn. 1)
16.52	16.67	-0.9
16.71	16.67	0.2
16.5	16.67	-1.0
17.21	16.67	3.2
15.67	16.67	-6.0

YOU can use to track FR and assess potential trends

(You are not required to report these to AQS, but you can use DASC to track them)



6-mo FR audits-what EPA does:

Meas Val (Y)	Audit Val (X)	d (Eqn 1)
3	2.92	2.74
3	3.07	-2.28

"m" (Eqn 8) =mean

0.23

"S" (Eqn 9) =sample standard dev

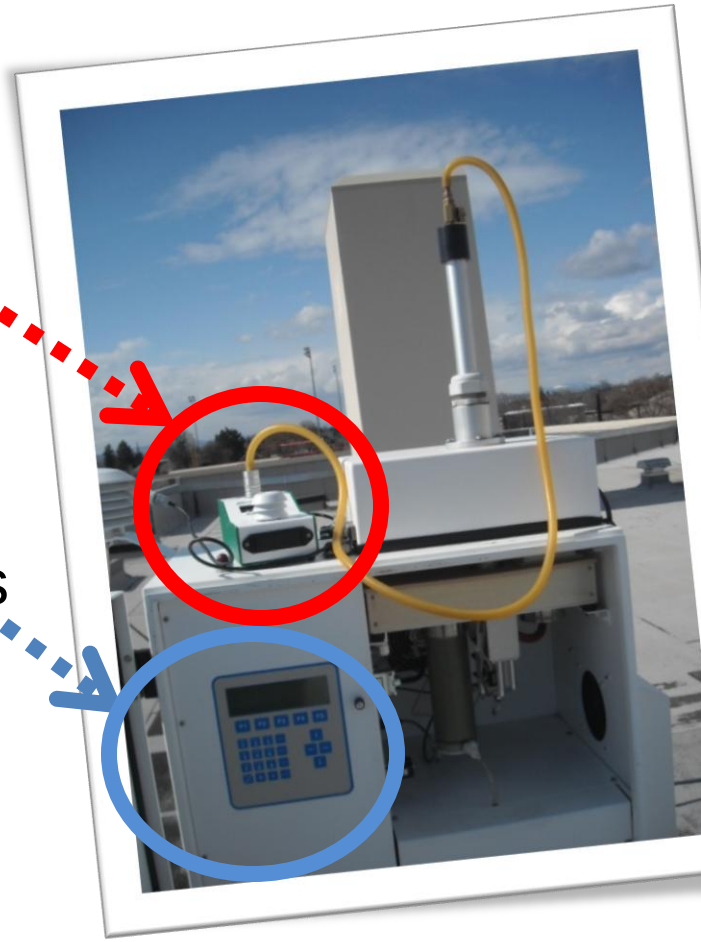
3.55 of the 6-month FR audits

95% Upper Probability Limit

7.2

95% Lower Probability Limit

-6.7



6-mo FR audits-what shows up in AMP255:

UALITY INDICATOR REPORT

Annual Flow Rate Audits

State Department Of Ecology)

This is just the mean of the 2 6-mo FR checks that DASC calculated for you

End Date	# Req	#Q w/ Data	% Complete	Criteria Met?	Obs / Q Q1	Q2	Q3	Q4	Avg %d	Flow Rate Conf. Limits Lower	Upper	% Between Conf. Limits
31-DEC-11	2	2	100	Y	1	0	1	0	0.2			
	33	36	97	88	11	6	10	9	0.1	-2.26	3.18	83
	33	36	97	88	11	6	10	9	0.1	-2.26	3.18	83

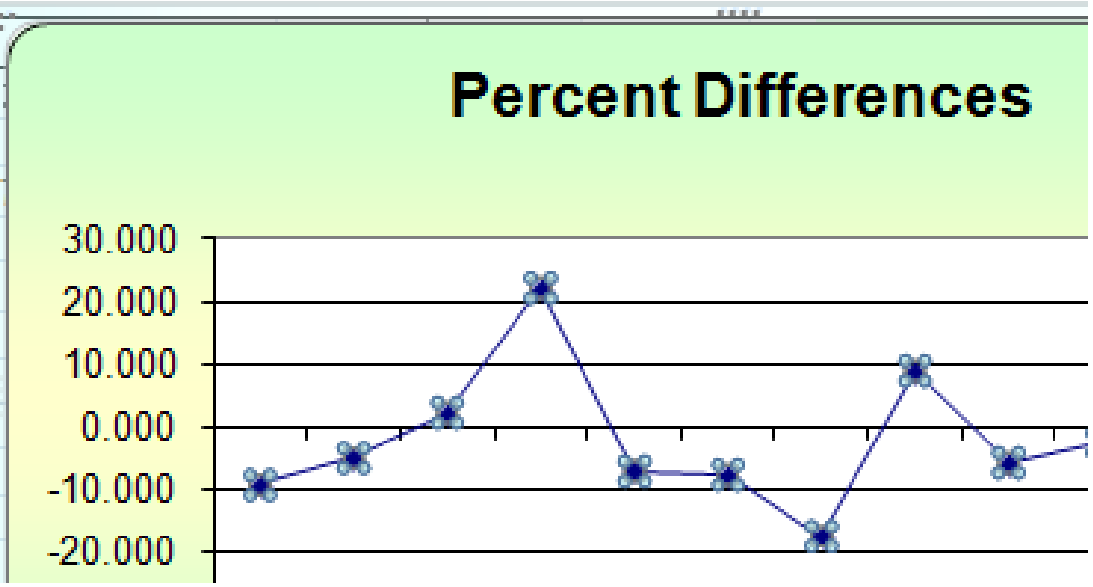
90% probability limits for your flow rate over whole PQAO

PM stats-collocated

- Use DASC for control chart

Precision Estimate (From Collocated Samples)

Meas Val (Y)	Audit Val (X)	d (Eqn 10)
5.05	5.55	-9.434
12.35	13	-5.128
14.67	14.35	2.205
9.59	7.68	22.119
10.51	11.3	-7.244
12.44	13.45	-7.802
3.78	4.51	-17.612
18.56	16.99	8.833
12.56	13.32	-5.873
7.68	7.89	-2.697



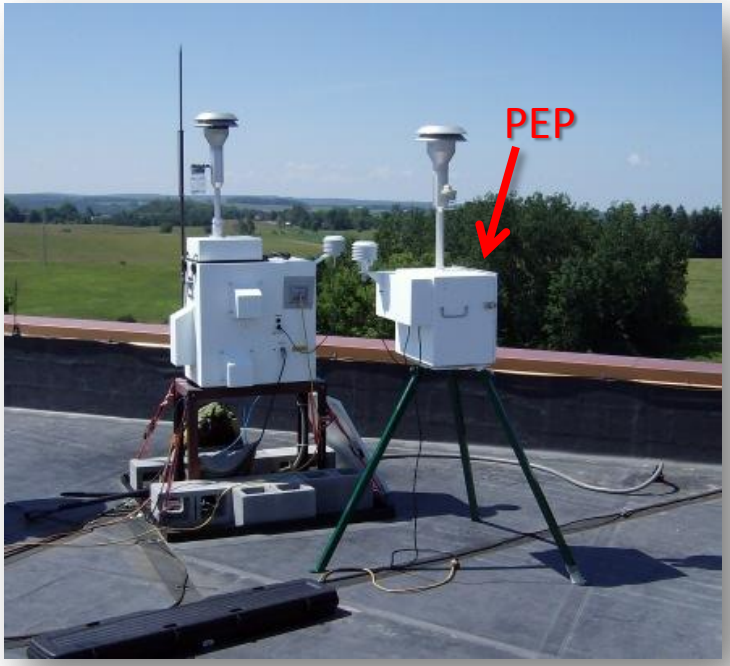
- And to check AMP 255

CV (%) (Eqn 11)
4.69

% Complete	CV
93	4.69

PM stats-PEP

- EPA uses to estimate BIAS (and when you get your PEP results you can use DASC to generate confidence intervals for your bias)



PM FR stats summary:

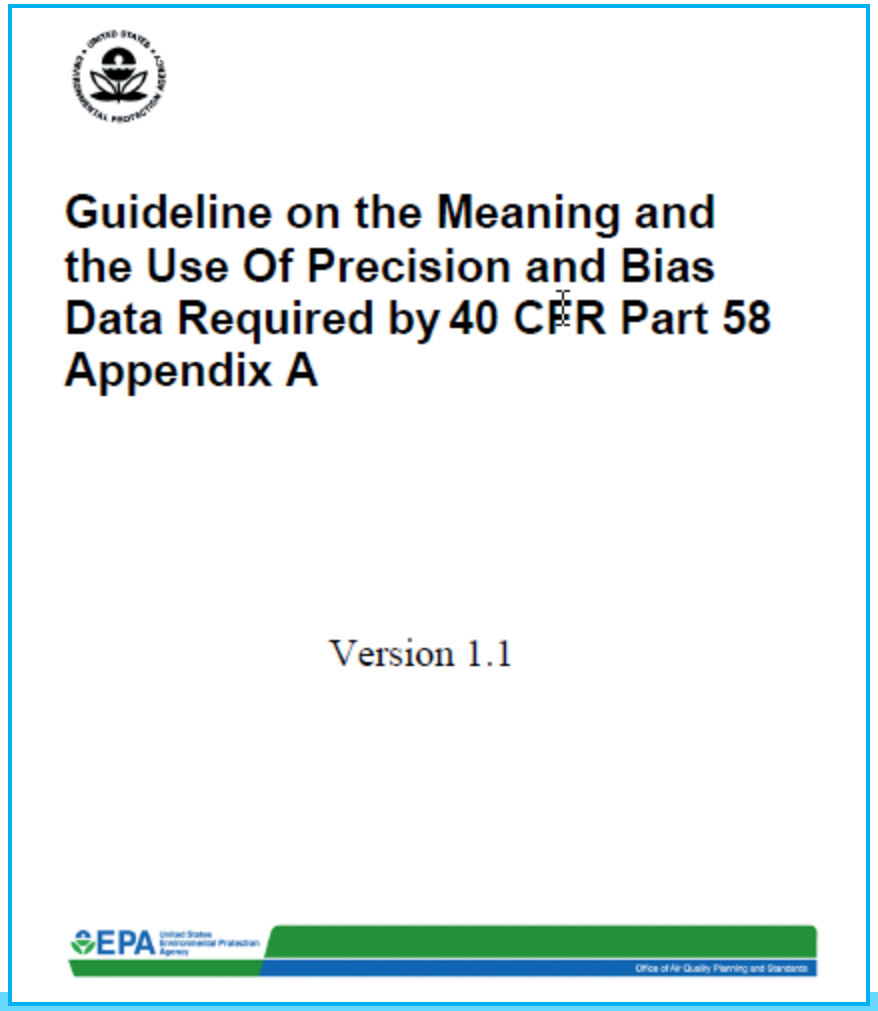
- Use d_i for monthly and 6-mo FR verifications
- Use DASC to plot monthly FR
- EPA uses 6-mo FR audits to generate limits on your FR over your entire PQAO; check these yourself in DASC
- PEP is used for independent national bias estimates
- Collocated data is used for precision estimates; you can calc in DASC also

CV (%) (Eqn 11)
4.69

← *Upper bound of CV*

Now for even more information:

- Reporting requirements of App. A
- Box and whisker charts EPA prepares 4 u



Reporting in App. A:

5.1 Quarterly and Annual Reports

- ***Tables*** with DASC/AMP stats
- Bias, precision, completeness
- P.E. results
- Brief explanations (several sentences)
- Corrective action
- Lots of ***charts***
- Available online:
- **http://itep68.itep.nau.edu/itep_downloads/Appendix_A_Resources/**

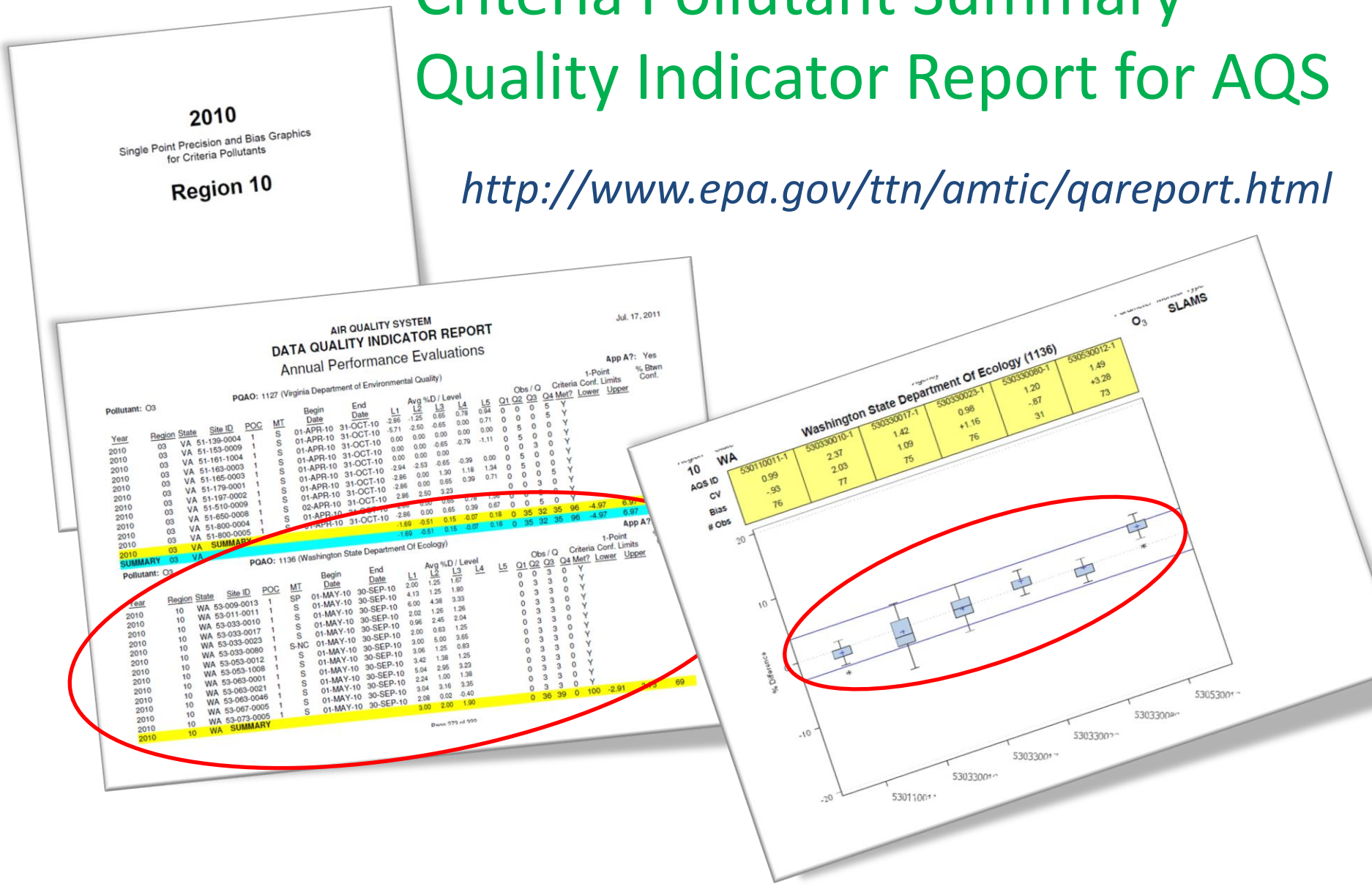
DEPARTMENT OF ECOLOGY
State of Washington

Air Monitoring Data Quality Assessment Report
Fourth Quarter
2011

Prepared by Donovan Rafferty

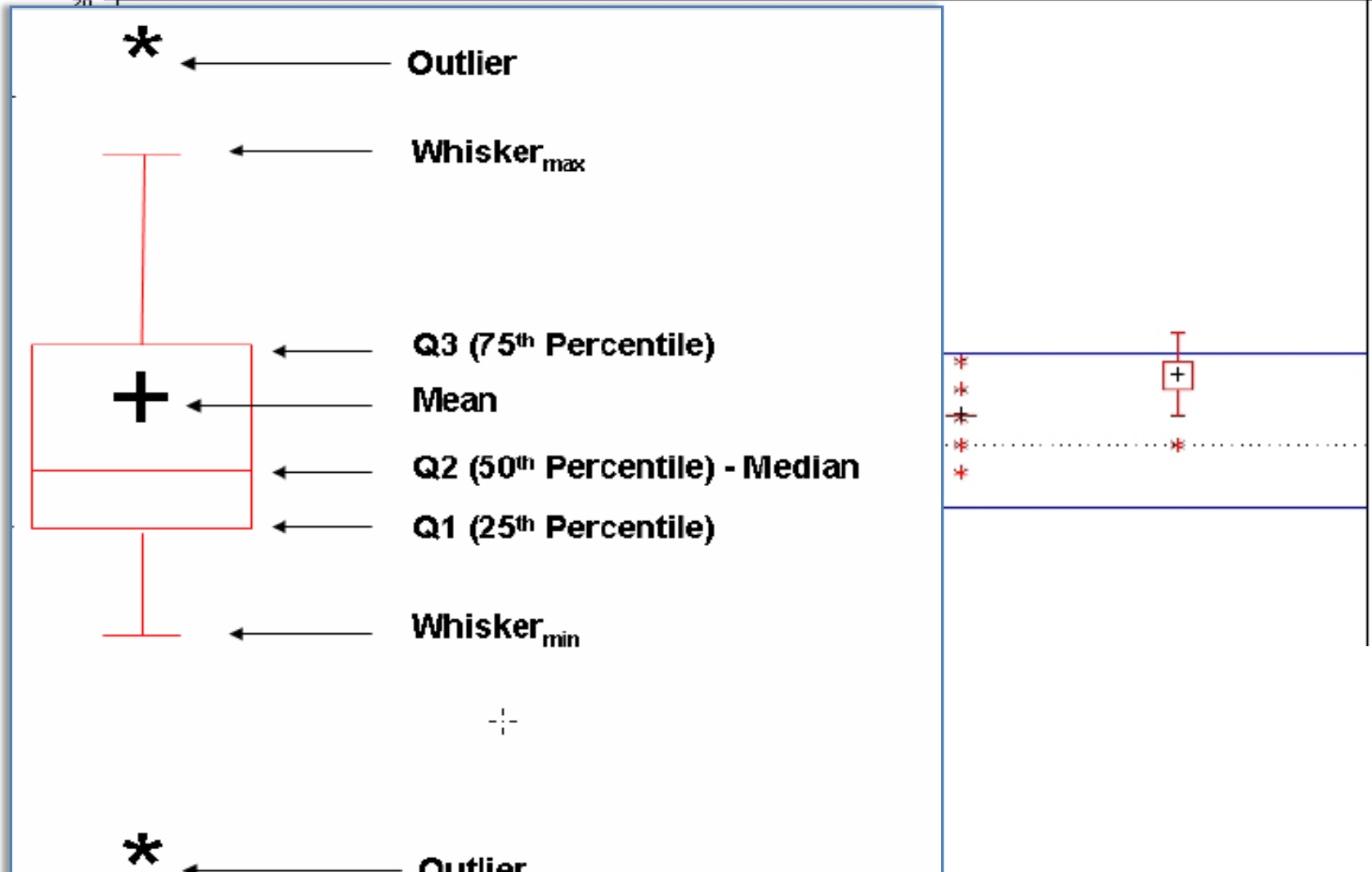
Criteria Pollutant Summary Quality Indicator Report for AQS

http://www.epa.gov/ttn/amtic/qareport.html



Region	State	Agency	Parameter
10	WA	Washington State Department Of Ecology (1136)	O_3

AQS ID	530110011-1	530330010-1	530330017-1	530330023-1	530330080-1
CV	2.08	1.21	1.64	0.98	1.23
Bias	1.60	+1.00	1.23	+1.52	+3.31
# Obs	153	153	144	151	152



Thanks!

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- Joe Cebe, Forest County Potawatomi Community, joe.cebe@fpotawatomi-nsn.gov
- Matt Plate, plate.plate.mathew@epa.gov
- Our materials at **http://itep68.itep.nau.edu/itep_downloads/Appendix_A_Resources/**